## REMARKS

Applicants thank the Examiner for the very thorough consideration given the present application. Claims 1 and 3-20 are currently pending in this application. Claims 3 and 4 have been withdrawn from further consideration. No new matter has been added by way of the present amendment. For instance, the amendment to claim 1 is supported by the Specification at, for example, page 9, lines 21-23, and page 15, lines 25-33. Accordingly, no new matter has been added.

In view of the amendments and remarks herein, Applicants respectfully request that the Examiner withdraw all outstanding rejections and allow the currently pending claims.

***Specification***

The Examiner objects to the amendment filed August 17, 2007 under 35 U.S.C. 132(a) "because it introduces new matter into the disclosure". Applicants respectfully traverse.

Applicants submit that an amendment to correct an obvious error does not constitute new matter where one skilled in the art would not only recognize the existence of error in the specification, but also the appropriate correction. See *In re Odd*, 443 F.2d 1200, 170 USPQ 268 (CCPA 1971). See also MPEP 2163.07.

The definition of the aspect ratio in the Specification as filed is erroneous, as evidenced by the attached Supplemental Material (A), excerpts from *Micromechanics of nanocomposites: comparison of tensile and compressive elastic moduli, and prediction of effects of incomplete exfoliation and imperfect alignment on modulus* (Polymer 43 (2002) pp. 369-387), and Declaration Under 37 CFR 1.132.

As discussed in the attached Supplemental Material A and Declaration, a lamellar particle has a specific shape (see Figure 1 on Supplemental Material A). In Figure 1, "a" represents the largest diameter of the particle. As disclosed at page 9, lines 21-27 of the present Specification, the present lamellar particle has an aspect ratio of 50 to 2,000. Based on the erroneous definition of the term "aspect ratio" provided in the Specification as filed, when "a" in Figure 1 is the largest diameter of the particle, the aspect ratio of the particle could not possibly be greater than 1, as "b" (the thickness of the particle) is smaller than "a". Thus, the particle could not possibly be a lamellar particle.

The enclosed excerpt from Polymer 43 (2002), pages 369-387 further evidences that the definition of the term "aspect ratio" provided in the Specification as filed is an obvious error. Furthermore, the enclosed excerpt evidences that the proposed amendment to the Specification filed on August 17, 2007 defines the term "aspect ratio" in accordance with the art-recognized definition of this term.

Thus, Applicants submit that the aspect ratio of a lamellar particle is the ratio of the longest diameter (the length of a portion having the longest diameter of the particle) to the thickness of the particle, as proposed in the amendment to the Specification filed on August 17, 2007.

In view of the above, Applicants respectfully request reconsideration and withdrawal of this objection, and entry of the August 17, 2007 amendment to the Specification.

***Issues Under 35 U.S.C. § 103(a)***

**Claims 1, 5-14 and 17-20**

Claims 1, 5-14 and 17-20 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Fenton et al. (U.S. 6,456,136) (hereinafter Fenton '136). Applicants respectfully traverse.

The Examiner asserts that Fenton '136 discloses a composite membrane structure comprising a porous polymeric matrix and a protective layer disposed adjacent to the porous polymeric matrix. The Examiner further asserts that the porous polymeric layer has a pore diameter of 0.025μm to about 1μm. Furthermore, the Examiner asserts that the protective layer comprises a binder, an ionically conductive solid, and a hygroscopic powder.

Applicants respectfully submit that the Examiner has failed to establish a *prima facie* case of obviousness. To establish a *prima facie* case of obviousness, the prior art reference (or references when combined) must teach or suggest all the claim limitations. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). Additionally, there must be a reason why one of ordinary skill in the art would modify the reference or combine reference teachings to obtain the invention. A patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. *KSR Int'l Co. v Teleflex Inc.*, 82 USPQ2d 1385 (U.S. 2007). There must be a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does. *Id.* The Supreme Court of the United States has recently held that the "teaching, suggestion, motivation test" is a valid test for obviousness, albeit one which cannot be too rigidly applied. *Id.* Rejections on obviousness grounds cannot be sustained by mere

conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness. *Id.*

The present invention is directed, *inter alia*, to an ion exchange membrane comprising a porous film and a surface layer, wherein the pores of the porous film are filled with a crosslinked ion exchange resin and the surface layer comprises a crosslinked ion exchange resin and a lamellar particle. In the presently claimed ion exchange membrane (see, for example, claim 1), both the crosslinked ion exchange resin which fills the pores of the porous film layer (A) and the crosslinked ion exchange resin which comprises the surface layer are crosslinked with a polyfunctional vinyl compound or a polyfunctional methacrylic acid derivative.

Applicants have discovered that an ion exchange resin obtained by blending a crosslinkable monomer becomes insoluble and has improved stability (see, for example, Applicants' Specification at page 15, lines 23-27). Fenton '136 fails to teach or suggest the use of crosslinked ion exchange resins in the polymeric and protective layers.

The composite membrane of Fenton '136 comprises a porous polymeric matrix, an ionically conductive solid and a binder. The protective layer comprises a binder and an ionically conductive solid (see Fenton '136 at column 3, lines 17-19).

Fenton '136 describes the binder present in the protective layer as follows (see Fenton '136 at col. 6, lines 25-29):

> *"Examples of preferred binders include, but are not limited to, ion exchange resins such as NAFION®, polystyrene sulfonic acid, and perfluorinated carboxylic acid resins."*

NAFION® is a trademark of DuPont Co., Ltd. and a copolymer of tetrafluoroethane and perfluorosulfonylethoxyvinyl ether, which is also known as "perfluorinated sulfonic acid polymer" (see column 2, lines 17-18 and 63-64 of Fenton '136). Both NAFION® and the polystyrene sulfonic acid have a sulfonic acid group ($-SO_3H$) as an ionic functional group. The perfluorinated carboxylic acid resins have a carboxylic acid group (-COOH) as an ionic functional group.

These ionic functional groups can be bonded to a divalent cation such as $Ca^{++}$ to form an ionic crosslink. However, even when this ionic crosslink is formed, the binder of Fenton '186 is not a crosslinked ionic exchange resin which is covalently crosslinked with a polyfunctional vinyl compound or a polyfunctional methacrylic acid derivative as presently claimed. The binder of Fenton '136 differs from the presently claimed crosslinked ionic exchange resin both in terms of crosslinking properties (ionic or covalent) and type (divalent cation or polyfunctional compound).

At page 5, lines 18-20 of the outstanding Office Action, the Examiner asserts that perfluorosulfonic acid (NAFION®) is a crosslinkable monomer. However, as discussed above, the crosslink formed by the perfluorosulfonic acid constituting NAFION® completely differs from the crosslink formed by the ion exchange resin of the present invention. Applicants submit that, if an ionic polymer like NAFION® is used in place of the ion exchange resin of the present invention, the surface layer cannot permeate non-ionic methanol due to its strong ionic property and cannot be used in a direct methanol type fuel cell.

Evidently, the cited reference fails to teach or suggest every limitation of the instant invention. Consequently, this rejection should be withdrawn.

Reconsideration and withdrawal of this rejection are thus respectfully requested.

**Claims 15-16**

Claims 15-16 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Fenton '136 in view of Roark et al. (U.S. 7,001,446) (hereinafter Roark '446). Applicants respectfully traverse.

The Examiner asserts that Roark '446 teaches a protective layer applied to a membrane to protect a catalyst from the "detrimental effects of feedstream and other contaminants". The Examiner further asserts that Roark '446 teaches that a protective layer of porous perovskites can be used to protect the membrane from poisoning. The Examiner argues that one of ordinary skill in the art would be motivated to use the protective layer materials of Roark '446 as the protective layer of Fenton '136 "to decrease fuel (feedstream) crossover".

Applicants respectfully submit that the Examiner has failed to establish a *prima facie* case of obviousness. As previously discussed, Fenton '136 fails to teach or suggest an ion exchange membrane comprising a porous film and a surface layer, wherein the pores of the porous film are filled with a crosslinked ion exchange resin and the surface layer comprises a crosslinked ion exchange resin and a lamellar particle. Roark '446 fails to cure these deficiencies.

Roark '446 is directed to a hydrogen-permeable membrane for separation of hydrogen from hydrogen-containing gases. Roark '446 does not disclose or suggest the inventive ion exchange membrane of the present application.

Evidently, the cited references, alone or in combination, fail to teach or suggest every limitation of the instant invention. For this reason alone, this rejection should be withdrawn.

Furthermore, assuming *arguendo* that Roark '446 cured the deficiencies of Fenton '136, it is noted that references cannot be arbitrarily combined. There must be some reason why one of ordinary skill in the art would be motivated to make the proposed combination of the primary and secondary references. *KSR Int'l Co. v Teleflex Inc.*, 82 USPQ2d 1385 (U.S. 2007). Courts have clearly established that, even when a combination of references teaches every element of a claimed invention, a rejection based on a *prima facie* case of obviousness is improper absent a motivation to combine. *Id.*

Fenton '136 is directed to porous membranes, whereas Roark '446 is directed to a non-porous multi-layer membrane. One skilled in the art would not be motivated to modify the porous layers of Fenton '136 by using the materials disclosed by Roark '446 for non-porous membranes.

Because the invention, as set forth in Applicants' claims, is not disclosed or made obvious by the cited prior art, reconsideration and withdrawal of this rejection are respectfully requested.

***Conclusion***

All of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicants therefore respectfully request that the Examiner reconsider all presently outstanding rejections and objections and that they be withdrawn. It is believed that a full and complete response has been made to the outstanding Office Action and, as such, the present application is in condition for allowance.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Marc S. Weiner, Reg. No. 32,181 at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§1.16 or 1.14; particularly, extension of time fees.

Dated: February 5, 2008

Respectfully submitted,

By _____

Marc S. Weiner
Registration No.: 32,181
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road
Suite 100 East
P.O. Box 747
Falls Church, Virginia 22040-0747
(703) 205-8000
Attorney for Applicant

Enclosures:
- Supplemental Material A
- Excerpts from *Micromechanics of nanocomposites: comparison of tensile and compressive elastic moduli, and prediction of effects of incomplete exfoliation and imperfect alignment on modulus* (Polymer 43 (2002) pp. 369-387)
- Declaration Under 37 CFR 1.132

Opposition to the amendment of the definition of aspect ratio

Since the particle used in the present invention is "a lamellar particle", it has substantially the following shape.

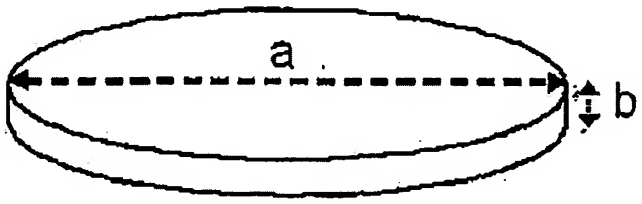


Fig. 1

Since the largest diameter of the above particle is "a", according to the current definition of aspect ratio (ratio of thickness to largest diameter = b/a), it is apparently abnormal that the aspect ratio is larger than 1.

Meanwhile, when the thickness is made large to achieve a b/a ratio of more than 1, the following shape is obtained. Since the largest diameter becomes "b" in this shape, the thickness/largest diameter ratio becomes b/b = 1. As a result, the thickness/largest diameter ratio cannot be larger than 1. If "a" is the largest diameter, a particle having this shape is "fibrous" and cannot be "a lamellar particle".

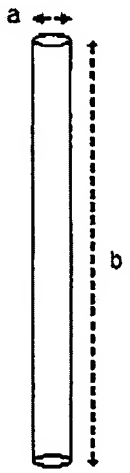


Fig. 2

From the above point of view, it is obvious for one of ordinary skill in the art that the current definition of aspect ratio (thickness/largest diameter ratio = b/a) is wrong.

ELSEVIER

Polymer 43 (2002) 369–387

polymer

www.elsevier.com/locate/polymer

# Micromechanics of nanocomposites: comparison of tensile and compressive elastic moduli, and prediction of effects of incomplete exfoliation and imperfect alignment on modulus☆

Douglas A. Brune, Jozef Bicerano*

*The Dow Chemical Company, M.E. Pruitt Research Center, 1702 Building, Midland, MI 48674, USA*

**Abstract**

This paper addresses three important aspects, neglected in all previous literature, of the micromechanics of nanocomposites reinforced by platelet-shaped fillers. (a) A model was developed to predict the buckling of platelets in reinforced materials under compressive loading. This model predicts a critical strain above which platelet buckling, and hence a reduction in the compressive modulus relative to the tensile modulus, would be expected to occur. It was used to show that compressive modulus should not be reduced relative to tensile modulus in a typical polypropylene nanocomposite. (b) A model was developed to account for the reduction of the reinforcement efficiency of clay platelets of high aspect ratio in a polymer matrix as a result of the incomplete exfoliation of platelets into 'pseudoparticle' stacks containing polymer layers sandwiched between successive clay platelet layers rather than into individual perfectly exfoliated and well-dispersed platelets. It was shown that incomplete exfoliation has a very significant detrimental effect on the reinforcement efficiency. (c) A model was also developed for the reduction of the reinforcement efficiency as a result of the deviation of the platelet orientation from perfect biaxial in-plane. It was shown that the deviation of the platelet orientation from perfect biaxial in-plane also has a very significant detrimental effect on the reinforcement efficiency. 

*Keywords:* Nanocomposites; Micromechanics; Tensile and compressive elastic moduli

## 1. Introduction

Nanocomposites consisting of highly anisotropic clay platelets dispersed in a polymeric matrix material [1–16] are of interest for many important industrial applications. For example, polypropylene nanocomposites are currently under development for automotive fascia. The platelet-shaped clay nanofillers have thicknesses of ~1 nm. Their aspect ratios (defined as diameter/thickness) can range from 10 to 1000. Their elastic (Young's) moduli are $\sim 10^2$ times those of typical a thermoplastic or thermoset, and $\sim 10^5$ times those of a typical elastomer. The platelets occur naturally in stacks. These stacks must be torn apart (in other words, 'exfoliated'), to disperse them in the polymeric matrix as highly anisotropic nanofillers. The dispersion of such platelets improves many important properties, including the elastic moduli, relative to the polymeric matrix materials.

The development of nanocomposite technology presents many scientific challenges. A better fundamental understanding, and the ability to make predictions, are very important in accelerating the development of this technology. In particular, theory and simulations are especially useful in addressing the following three key research challenges:

- *Thermodynamics and kinetics of exfoliation.* This challenge is at the heart of the development of nanocomposite technology. Both the processing characteristics of the suspensions of clay platelets in polymers and the final properties of the fabricated articles made from these suspensions depend on the exfoliation and dispersion of the platelets. There is a significant amount of ongoing research in this area. For example, see Vaia and Giannelis [17,18] and Balazs et al. [19,20].
- *Rheology of dispersions of clay platelets in molten polymers.* The main objective of work in this area is to help optimize the processing characteristics during fabrication. The shear viscosity is of special interest. For example, see Bicerano et al. [21].
- *Elastic properties of nanocomposite fabricated articles.* Nanocomposite mechanics is not yet well-understood. This manuscript addresses, by developing analytical

☆ This paper was originally submitted to *Computational and Theoretical Polymer Science* and received on 27 March 2001; received in revised form on 20 July 2001; accepted on 20 July 2001. Following the incorporation of *Computational and Theoretical Polymer Science* into *Polymer*, this paper was consequently accepted for publication in *Polymer*.

* Corresponding author. Tel.: +1-517-636-6980; fax: +1-517-636-5406.
*E-mail address:* biceranoj@dow.com (J. Bicerano).

0032-3861/02/$ - see front matter 
PII: S0032-3861(01)00543-2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

| | |
|---|---|
| IN RE APPLICATION OF | : |
| HITOSHI MATSUOKA | :EXAMINER: DOVE, TRACY MAE |
| SERIAL NO.: 10/743,146 | : |
| FILED: December 23, 2003 | :GROUP ART UNIT: 1745 |
| FOR: ION EXCHANGE MEMBRANE AND PRODUCTION PROCESS THEREFOR | : |

DECLARATION UNDER 37 C.F.R. 1,132

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

Sir,

I, Kenji Fukuta, am one of the inventors of the present invention. I have confirmed that the following definition at page 9, lines 28-31 in the specification of the present application is wrong.

"The aspect ratio of the lamellar particle is the ratio of the thickness to the largest diameter (the length of a portion having the longest diameter of the particle) of the lamellar particle."

I believe that the above definition should be corrected as follows.

"The aspect ratio of the lamellar particle is the ratio of the longest diameter (the length of a portion having the longest diameter of the particle) to the thickness of the lamellar particle."

The undersigned declares further that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements

may jeopardize the validity of this application or any patent issuing thereon.

Further declarant saith not.

Kenji Fukuta

Signature

January 22, 2008

Date

Customer Number
22850
Tel. (703) 413-3000
Fax. (703) 413-2220
(OSMMN 07/05)